NPAL Acoustic Noise Field Coherence and Broadband Full Field Processing

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LONG-TERM GOALS

This effort concerns the forward and back scattering from seamount and ocean ridge structure including i) the blockage due to seamounts; ii) the up/down slope issues for converting from shallow to deep water propagations and *vice versa*; iii) 3D effects caused by horizontal refraction

OBJECTIVES

The immediate objectives involve analyzing the data from the SPICEX-LOAPEX-BASSEX cruises conducted between May 2005 and October 2005. Our efforts focus on the BASSEX experiment where recorded data on a towed array in the vicinity of the Kermit-Roosevelt seamounts and on the shoaling region north of Kauai.. Our objectives concern understanding the forward and backscattering from the seamounts and the up/down slope conversion mechanisms for a shoaling bathymetry

APPROACH

The approach used was to insonify the Kermit-Roosevelt seamount complex illustrated in Figure 1 using sources deployed by the SPICEX and LOAPEX sources. These seamounts shoal the most in the northeas Pacific and are located along the Mendocinco fracture zone as clearly indicated in the contouring on the left part of Figure 1. The northerly peak shoals to roughly 912 m and the southerky one to 1426 using the multibeam on the *R/V Revelle* during the experiment. The SPICEX souurces S! and S2 and insonify the seamounts from the southeast and south west directions at a range of rougly 500 km. There were two depths for thes sources. (We note that these depths differ from commonly used bathymetric charts by as much as 300 m.) The LOAPEX

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14. ABSTRACT
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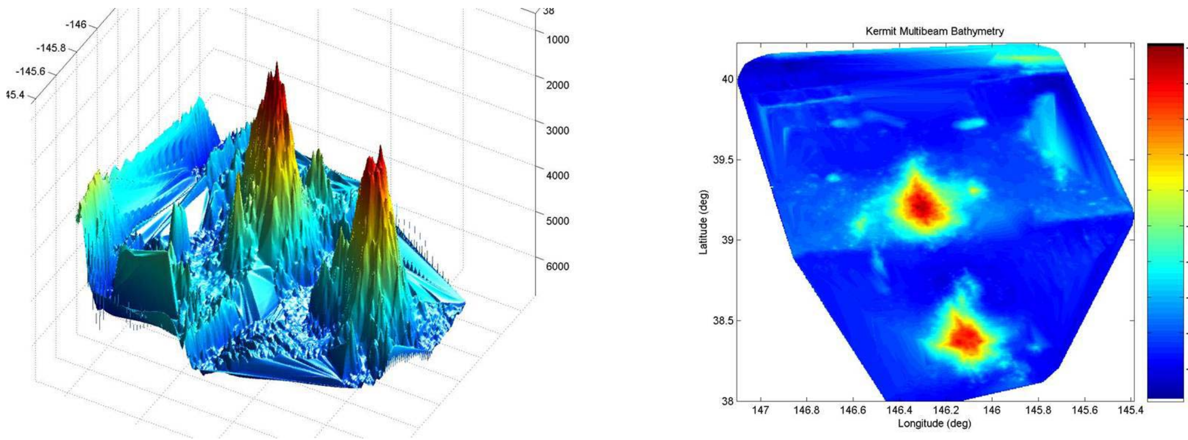


Figure 1: Isometric and contour plots of the Kermit-Roosevelt Seamount complex used for the forward scattering studies of the BASSEX Experiment. The seamounts are approximately 40 km at the base and shoal to 1000 m depth

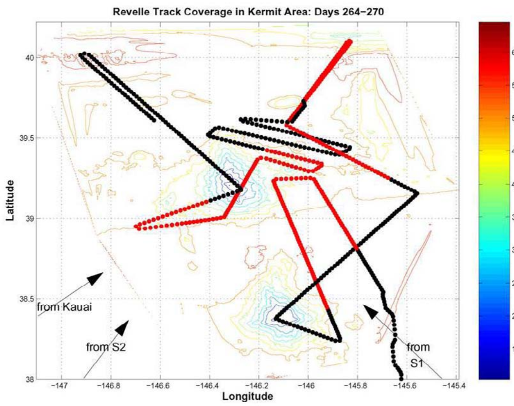
source insonified the seamounts from several ranges as it transited from east to west. In addition the ATOC/NPAL source providided insonification from the northside of Kauai.

The data were taken on the ONR FORA (Four Octave Array maintained and staffed by Pennsylvania State University. The array for the BASSEX purposes had 192 sensors with a 32 wavelength length at 250 Hz. (The additional sensor beyond 64 are for nesting for coverage at higher frequencies. The array towed well; howver, there were some data spikes resulting from the buffering logic because of the high sample rates used. In addition, complere mjultibeam coverage was acquired.

WORK COMPLETED

We have complted a prelimnary analyis of the data from the BASSEX esperiment which is discribed below. The results section sill compare some date data with theoretical predictions**.**

Figures 2 and 3 illustrate the forward scattering of the Kermit (northerly) seamount. Figure 2a on the left indicates the track plan of the *R/V Revelle* with the towed array. Note that there is ample coverage to near the behind the seamount.. The right panel is formed by pulse compressing the M sequences and accumulating the energy (an incohernent sumation) for all the the scattered energy for a transmission from SPICEX source S1 approximately 500 km to the southeast. We can observe that there is strong shadowing directly behind the seamount, but more notable is the diffracted energy to both the noertheas and southwest of the seamount. In addition, there is an indication of some enhancement from Elvis (A shipboard surrogagte for the southerly seamount coined by the CoPI, the resident shipboard musician.) . In addition one can see the reestablishment of convergence zones behind the seamount with the rise in energy after a null. This is conistent with ealrier theoretical modeling by Jensen, *et al*. (Jensen).



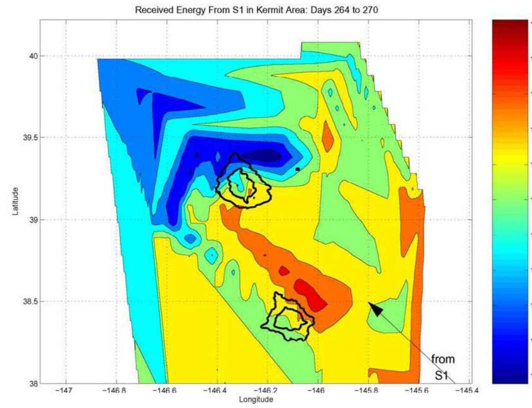
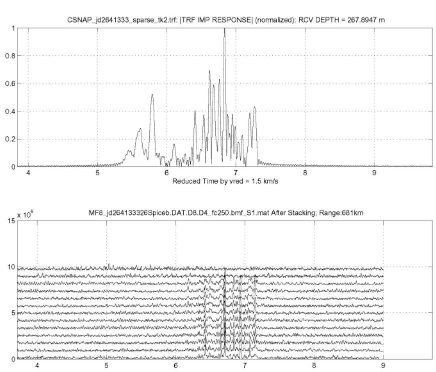


Figure 2a (left): The tracks of the R/V Revelle during the BASSEX experiment indicating the density of coverage for forward scattering. Figure 2b (right): An accumulation of the energy at the output of the pulse compression for all the transmission from on of the depth of a source at S1. Note the low levels behind and to the left and right of the seamount.

RESULTS

Figure 3 illustrates a theoretical prediction of the arrival structure for ranges from 0 to 1000 km at 20 km intervals. Each raster is a matched filter output predicted by the range dependent CSNAP program. Figure 3a on the left indicates the time series from a eception behind Kermit. Note that all the early and deep diving rays have been cut off. On the right side the predictions versus range from 20 to 100 km. At ranges before 500 km we observe the deep cycling rays which can rise to the array depth at 300 m. At the range of the seamount we can see the impact were these rays are scattered yet some energy propagates over the seamount. The analysis of predicting the exact shadowing using full 3D codes will be our objective this year.



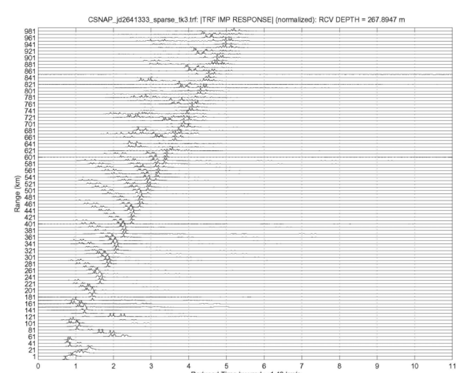


Figure 3a (left): Pulse compressed multi-channel data for a range just behind the Kermit seamount from an S1 source. Figure 3b (right): CSNAP prediction of the receptions for ranges from 20 to 1000 km at 20 km. We can note where the scattering from the seamount begins as well as the traditional deep cycling ray paths before the seamount. Travel time is the horizontal. Raster plots of reception are on the right.

IMPACT / APPLICATIONS

Understanding bottom interaction with seamounts and up slope / down slope propagation are subjects not very well covered with experimental results especially with regard to the issues of shadowing and horizontal refraction. These are among the first data with a towed array which can resolve direction of arrival which have been performed. We were fortunate to have the coded signals with precise propagation launch time and navigation such that quantitative directional analyis can be performed on experimental data and be compared to the evolving set of both modal and parabolic equation methods which include full 3D effects. Geologic features such as these are very common in the WESTPAC region.

RELATED PROJECTS

Matched Field Processing and Adaptive Processing in Snapshot Limited Environments, ONR Grant N00014-01-0257: This project concerns limits on adaptive array processing and statistical uncertainty for the performance of sonar systems.

Random Matrix Theory and Adaptive Array Processwing, ONR Grant N00014-05-0806: This was funded by the head of the Environmental Sciences with a small grant to sponsor the two day SEA05 Workshop where the coupling between work by statisticians on random matrices and adaptive array processors was explored. It was by all accounts a very successful workshop and a uncovered a very promising area for predicting the performance of adaptive processors.

Undersea Persistent Surveillance, Penn State Univ Award S05-06: This project is part of ONR's PLUS (Persistent Littoral Undersea Serveillance Network. This PI is part of the signal processing and acoustic communications efforts as well as the advisory panel..

(AREA) Adaptive Rapid Environmental Assessment, ONR Grant N0014-01-0187:. This Grant with Henrik Schmidt and A. B. Baggeroer as PI's was part of the ONR Uncertainty DRI.

Submarine Superiority Technical Advisory Group, (SSTAG).: This panel is sponored by N775 to review and advise the USN on advances on submarine detection, classification, localization and tracking as well as special efforts as requested by N77.

Maritime Superiority Technical Advisory Group, (MSTAG) : N77 & SPAWAR sponsor this panel to provide adivice on the construction and installation of fixed distributed systems.

Distributed Remote Surveillance Panel (DRS): This panel was commissioned by the CNO for the Naval Studies Board to review all efforts associated with distributed systems . The PI is CoChair of this NSB/Academy Panel

Kevin Heaney also participated on the BASSEX cruise and his analysis is focusing upon the upslope/down slope connversion bsed upon data take from the Kauai source of the ATOC source north of Kauai.

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HONORS/AWARDS/PRIZES

Rayleigh - Helmholtz Medal, Acoustical Society of America, Spring 2003 (not reported last year)

Packard Medal, Monterey Bay Aquarium Research Institute, Moss Landing, CA, March 2004